REMARKS

Applicants respond hereby to the non-final Office Action mailed on March 5, 2009, which set a three month period for response.

In the non-final Office Action, claims 37-64 are rejected under 35 USC §112, first paragraph, as non-enabling. Claims 38 and 39 are rejected under 35 USC §112, second paragraph, as indefinite. Claims 36-41, 44-50, 52, 54, 57-59 and 62-64 are rejected under 35 USC §102(b) in view of British Patent document No. GB 1538924 (GB '924).

Initially, applicants express their appreciation to the Examiner for the indication of the allowability of claims 42 and 43. Applicants, however, opt not to amend claims 42 and 43 to independent form, at least for the reasons set forth below.

35 USC §112, 1st paragraph

In the rejection of claims 37-64 under 35 USC §112, first paragraph, the Examiner asserts that the connective structural relationship of the elements regarding the timing of the knitting, drawing apparatus and twisting is not included in the claims, and is not enabled by the disclosure.

In response, applicants have amended independent claims 37 and 46 to more clearly articulate the connective structural relationship of the claimed elements, including the timing of the knitting, drawing apparatus and twisting that is so critical and essential to the invention as claimed.

Claim 37 as amended now recites a method for producing a circular weft knitted tubular fabric on a circular weft knitting machine. The method includes drawing a

continuous fiber band (5) in a drafting device (14) to obtain a drawn continuous fiber band (5); twisting the drawn continuous fiber band (5) supplied from the drawing device (14) in a spinning device (22, 23; 26, 29) to continuously obtain a yarn material (4, 7) at an outlet end (24, 30) of the spinning device (22, 23; 26, 29); feeding the yarn material (4, 7) obtained at the outlet end (24, 30) of the spinning device (22, 23; 26, 29) directly into a knitting point (16) of the circular weft knitting machine; and forming loops (1) with the yarn material (4, 7) at the knitting point for producing the circular weft knitted tubular fabric without unwinding the yarn material (4, 7) from a supply bobbin.

Claim 46 as amended now calls out apparatus for producing a circular weft knitted tubular fabric. The apparatus includes a circular weft knitting machine comprising having knitting needles (17) and at least one knitting point (16) configured to form loops (1) from a continuous yarn material (4, 7); drawing equipment (14) is configured to draw an endless fiber band (5); and a spinning device (22, 23; 26, 29) is configured to receive the fiber band from the drawing equipment (14), to twist the fiber band (5) for the formation of the continuous yarn material (4, 7) to the at least one knitting point (16) for directly knitting the circular weft knitted tubular fabric with the yarn material (4, 7) delivered from the spinning device (22, 23; 26, 29).

Support for the method and apparatus as claimed is found in applicants' disclosure, as filed. The continuous process for producing the circular weft knitted tubular fabric includes first drafting a fiber band of roving in drawing device (14) to a pre-selected thickness (Figs. 7, 8 and 12 and as described in the Specification at page 10, line 9, through page 11, line 22). Then, the preprocessed fiber band or roving is spun in spinning device 21, 22 or 26, 29 (Figs. 7, 8) to provide more strength, and delivered by

drawing device (14). This enables safe transport of the fiber band to the knitting machine without breaking. Loops are then formed with the fiber band in its form a continuous yarn (4, 7) to avoid commonly used intermediate steps of winding the yarn coming from a spinning machine onto a supply bobbin and the further steps of winding the yarn on or off intermediate spools.

The amended independent claims should make clear that production of the circular weft knitted tubular fabric is carried out in a continuous and complete process starting from the fiber band, sliver or roving and ending with the loop fabric with one and the same apparatus and in one and the same plant (method).

Applicants respectfully assert, therefore, that claims 37 and 46, as amended, and claims 38-45 and 47-64 that depend therefrom, are fully enabled under 35 USC §112, first paragraph, and requests withdrawal of same claim rejections.

35 USC §112, 2nd paragraph

In the rejection of claims 38 and 39 under 35 USC §112, second paragraph, applicant respectfully asserts that the use of the term "unconventional yarn" in claims 38 and 39, is readily clear and definite in view of applicants' disclosure, and that the distinction between conventional and unconventional yarn is readily understood in view of the disclosure and conventional arts.

The Specification uses the term "conventional yarn" for a yarn that is manufactured utilizing "ring spinning." Ring spinning is well known, and believed to be the most commonly used, or most conventional yarning process. As distinguished from ring spinning, rotor spinning, jet spinning, and methods for making bundle yarns or

wrapped yarns are unconventional, i.e., methods for generating "unconventional yarn" as used herein As used herein, conventional yarn is made by ring spinning, and unconventional yarn is made by other spinning methods; see page 1, line 27, to page 2, line 3; page 9, line 26 to page 10, line 25.

Hence, what is meant by use of the term unconventional yarn (21) used in claims 38 and 39, and how to distinguish between conventional and unconventional yarn is believed to be clear and definite in view of applicants' disclosure, as explained. Accordingly, applicants respectfully request withdrawal of the rejection of claims 38 and 39 under 35 USC §112, 2^{nd} paragraph.

35 USC §102(b)

GB '924 discloses production of an intermediate product in the form of a warp knitted yarn and the transfer of the yarn onto a supply spool. GB '924 does not disclose a method or an apparatus for producing a circular, weft knitted tubular fabric (see attached 7 page "enclosure No. 1"), does not disclose a circular weft knitting machine, nor utilize and rotate needles around their own axes (page 6, lines 86-89) to produce a knit yarn by turning the single needle about its axis during the draw-down cycle. Such operation is typical for warp as distinguished from weft knitting machines (see two-page attached enclosure No. 2).

GB '924 discloses a continuous fiber roving drawn in a drawing device, where the fiber band is provided with twists on its way from the drawing device to the knitting needles 222, 224 by means of at least one spinning device 216, 254. The result is a yarn 212, not a fabric (page 5, lines 69-73). At page 2, lines 1-5, a chord-like knitted

structure that is described as a new and unique yarn which, when formed into fabric, provides a superior texture and "hand" qualities. Page 7, lines 11-17, states that the term "chordlike" structure is intended to include yarn, thread, continuous filaments, spun filaments, roving, sliver and like textile products.

The GB '924 yarn is made of warp stitches and consists either of only one stitch wale (as shown in Figs. 16-18) or of two stitch wales (as shown in Fig. 19). One skilled in the art would not be able to produce such a fabric using a weft knitting technique, nor to produce such a chord-like yarn in a modern weft knitting machine. Warp loops become entangled in the needle hooks or needle latches. Nothing in GB '924 hints at how the chord-like yarn could be used in a modern weft knitting machine, or how to achieve a uniform stitch formation by means of weft knitting a fabric with such a cord-like yarn.

In view of the fact that amended independent claims 37 and 46 recites these limitations, which are not found in or suggested by GB '924, GB '924 does not anticipate amended independent claims 37 and 46.

Applicants further respectfully assert that GB '924 is not a proper reference under 35 USC §102 pursuant to the guidelines set forth in the last paragraph of MPEP §2131, where it is stated that "a claim is anticipated only if each and every element as set forth in the claims is not found, either expressly or inherently described, in a single prior art reference," and that "the identical invention must be shown in as complete detail as is contained in the ... claim."

Amended independent claims 37 and 46 are therefore patentable under 35 USC §102(b) over GB '924. Because claims 38, 39, 40, 41, 44 and 45 depend from claim 37,

they are patentable for at least the reasons stated above for the patentability of claim 37 over GB '924. Because claims 47-50, 52, 54, 57-59 and 62-64 depend from independent claim 46, they are patentable for at least the reasons stated above for the patentability of claim 36 over GB '924.

Applicants, therefore, respectfully request withdrawal of the rejection of claim 36-41, 44-50, 52, 54, 57-59 and 62-64 under 35 USC 35 USC §102(b) over GB '924, and the allowance of each of pending claims 36-64.

The application in its amended state is believed to be in condition for allowance. Action to this end is courteously solicited. Should the Examiner have any further comments or suggestions, the undersigned would very much welcome a telephone call in order to discuss appropriate claim language that will place the application into condition for allowance.

Respectfully submitted,

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textile

Overview

Any filament, fibre, or yarn that can be made into fabric or cloth, and the resulting material itself.

The word originally referred only to woven fabrics but now includes knitted, bonded, felted, and tufted fabrics as well. The basic raw materials used in textile production are fibres, either obtained from natural sources (e.g., **wool**) or produced from chemical substances (e.g., **nylon** and **polyester**). Textiles are used for wearing apparel, household linens and bedding, upholstery, draperies and curtains, wall coverings, rugs and carpets, and bookbindings, in addition to being used widely in industry.

Main

any filament, fibre, or yarn that can be made into fabric or cloth, and the resulting material itself.

The term is derived from the Latin *textilis* and the French *texere*, meaning "to weave," and it originally referred only to woven fabrics. It has, however, come to include fabrics produced by other methods. Thus, threads, cords, ropes, braids, lace, embroidery, nets, and fabrics made by weaving, knitting, bonding, felting, or tufting are textiles. Some definitions of the term textile would also include those products obtained by the papermaking principle that have many of the properties associated with conventional fabrics.

This article surveys the development of textiles and the history and development of the **textile industry**. It treats in some detail the processes involved in the conversion of fibres to yarn, fabric construction, finishing operations applied to textiles, uses of textile materials, and the relationship between the producer and the consumer. Information about specific natural and synthetic textile fibres such as wool, mohair, nylon, and polyester are treated in separate articles.

Development of textiles and the textile industry » From prehistoric times to the 19th century » Early textile production

Textile structures derive from two sources, ancient handicrafts and modern scientific invention. The earliest were **nets**, produced from one thread and employing a single repeated movement to form loops, and **basketry**, the interlacing of flexible reeds, cane, or other suitable materials. The production of net, also called limited thread work, has been practiced by many peoples, particularly in Africa and Peru. Examples of prehistoric textiles are extremely rare because of the perishability of fabrics. The earliest evidence of **weaving**, closely related to basketry, dates from Neolithic cultures of about 5000 bc. Weaving apparently preceded spinning of yarn; woven fabrics probably originated from basket weaving. Cotton, silk, wool, and flax fibres were used as textile materials in ancient Egypt; cotton was used in India by 3000 bc; and silk production is mentioned in Chinese chronicles dating to about the same period. The history of spinning technology will be touched on below in the section **Production of yarn: Spinning** and that of weaving technology in the section **Production of fabric.**

Development of textiles and the textile industry » From prehistoric times to the 19th century » Early textile production » Early fabrics

Many fabrics produced by the simple early weaving procedures are of striking beauty and sophistication. Design and art forms are of great interest, and the range of patterns and colours is wide, with patterns produced in different parts of the world showing distinctive local features.

Yarns and cloth were dyed and printed from very early times. Specimens of dyed fabrics have been found in Roman ruins of the 2nd century bc; tie-and-dye effects decorated the silks of China in the **T'ang dynasty** (ad 618–907); and there is evidence of production of printed textiles in India during the 4th century bc. Textiles found in Egypt also indicate a highly developed weaving craft by the 4th century ad, with many tapestries made from linen and wool. Persian textiles of very ancient origin include materials ranging from simple fabrics to luxurious carpets and tapestries.

Development of textiles and the textile industry » From prehistoric times to the 19th century » Early textile production » Textiles in the Middle Ages

By the early Middle Ages certain Turkish tribes were skilled in the manufacture of carpets, felted cloths, towels, and rugs. In Mughal India (16th–18th century), and perhaps earlier, the fine muslins produced at Dacca in Bengal were sometimes printed or painted. Despite the Muslim prohibition against representation of **living things**, richly patterned fabrics were made in Islāmic lands.

In Sicily, after the Arab conquest in ad 827, beautiful fabrics were produced in the palace workshops at Palermo. In about

Some manufacturers attach trademarks and quality labels to tested goods, and licensed trademarks are often associated with particular processes for which the manufacturer has been granted a license. The terms of the license require the manufacturer to ensure that his products meet the standards laid down by the proprietors of the particular process.

Production of yarn

Yarn is a strand composed of fibres, filaments (individual fibres of extreme length), or other materials, either natural or man-made, suitable for use in the construction of interlaced fabrics, such as woven or knitted types. The strand may consist of a number of fibres twisted together; a number of filaments grouped together but not twisted; a number of filaments twisted together; a single filament, called a monofilament, either with or without twist; or one or more strips made by dividing a sheet of material, such as paper or metal foil, and either twisted or untwisted. The properties of the yarn employed greatly influence the appearance, texture, and performance of the completed fabric.

Production of yarn » Textile fibres » Raw materials

Fibres are units of matter having length at least 100 times their diameter or width. Fibres suitable for textile use possess adequate length, fineness, strength, and flexibility for yarn formation and fabric construction, and for withstanding the intended use of the completed fabric. Other properties affecting textile fibre performance include elasticity, crimp (waviness), moisture absorption, reaction to heat and sunlight, reaction to the various chemicals applied during processing and in the **dry cleaning** or laundering of the completed fabric, and resistance to insects and microorganisms. The wide variation of such properties among textile fibres determines their suitability for various uses.

The first fibres available for textile use were obtained from plant and animal sources. Over a long period of experimentation with the many **natural fibres** available, cotton, wool, jute, flax, and silk have become recognized as the most satisfactory. The commercial development of man-made fibres began late in the 19th century, experienced much growth during the 1940s, expanded rapidly after **World War II**, and in the 1970s was still the subject of extensive **research and development**. This group includes regenerated fibres, such as rayon, made from fibre-forming materials already existing in nature and manipulated into fibrous form, and **synthetic fibres**, with the fibre-forming substance produced from chemicals derived from such sources as coal and oil, and then made into such fibres as nylon and polyester.

Production of yarn » Textile fibres » Factors affecting cost

The cost of fibres is determined by availability, the kind and amount of processing required, and their versatility. Natural fibres usually require extensive land area for their production, are affected by climatic conditions, and must frequently be transported long distances to the point of manufacture. Because quantity and quality are not easily controlled, prices tend to fluctuate. Research has been directed toward improving various properties during the manufacturing processes.

Man-made fibres can usually be produced near the point of use; their production does not require large land areas; they can be manufactured quickly, in desired quantities, with specific built-in properties; and they require little advance preparation for conversion to yarn. Initial costs are high because of the production equipment employed, but prices tend to be stable and may be reduced as production expands. Research has been directed toward improving the properties of man-made fibres and developing types suitable for specific purposes.

Although the major natural fibres continue to dominate the textile industry, production and consumption of synthetic fibres are growing.

Production of yarn » Conversion to yarn

Because filaments, such as silk and the man-made fibres, have extreme length, they can be made into yarn without the spinning operation necessary for the shorter staple fibres. When grouped together in a loose, continuous rope without twist, man-made filaments are called tow. Filaments may be loosely twisted together to form yarns of a specified thickness. Staple fibres, such as **cotton**, only a few inches long, must be tightly twisted together to produce satisfactory length.

Filament yarns are usually thin, smooth, and lustrous; staple yarns are usually thicker, fibrous, and without lustre. Man-made filaments cut to a predetermined short length become staple fibres, usually described by combining the fibre name with the term staple, as in rayon staple.

Production of yarn » Conversion to yarn » Treatment of raw fibre

In modern mills, most fibre-processing operations are performed by mechanical means. Such natural fibres as cotton, arriving in bales, and wool, arriving as fleece, are treated at the mill to remove various foreign materials, such as twigs and burrs. Wool must also be treated to remove suint, or wool grease; silk must be treated to remove sericin, a gum from the cocoon, and the very short silk fibres, or waste silk. Raw linen, the fibre of flax, is separated from most impurities before delivery. Man-made fibres, since they are produced by factory operations, rarely contain foreign materials. Blending, frequently employed for natural fibres, involves mixing fibres taken from different lots to obtain uniform length, diameter,

Cotton, wool, waste silk, and man-made staple are subjected to **carding**, a process of separating individual fibres and causing many of them to lie parallel, and also removing most of the remaining impurities. Carding produces a thin sheet of uniform thickness that is then condensed to form a thick, continuous, untwisted strand called sliver.

When very fine yarns are desired, carding is followed by combing, a process that removes short fibres, leaving a sliver composed entirely of long fibres, all laid parallel, and both smoother and more lustrous than uncombed types. Slivers may be loosely twisted together, forming roving. Hackling, a process applied to straighten and separate flax, is similar to combing.

Production of yarn » Conversion to yarn » Spinning » Early spinning methods

Spinning is the process of drawing out and twisting fibres to join them firmly together in a continuous thread or yarn. Spinning is an indispensable preliminary to weaving cloth from those fibres that do not have extreme length. From early times through the Middle Ages spinning was accomplished with the use of two implements, the **distaff** and the spindle. The distaff was a stick on which the mass of fibres was held. The drawn-out length of fibre was fastened to the weighted spindle, which hung free. The spinner whirled the spindle, causing it to twist the fibre as it was drawn from the distaff. As a length was drawn out the operation was halted, the new yarn wound on the spindle and secured by a notch, and the operation repeated. The **spinning wheel**, invented in India and introduced to Europe in the Middle Ages, mechanized the process; the spinning of the wheel supplanted the whirl of the weighted spindle, and after each operation the spinner wound the new yarn on the spindle. This was accomplished simply and speedily by holding the yarn outstretched with the left hand and feeding it as the wheel was spun in the reverse direction.

An important advantage conferred by the spinning wheel was the fact that it tended to add more twist at thin places in the forming yarn and to draw out the thicker places, giving a more uniform yarn.

The spinning wheel continued in use into the 19th century, receiving an important improvement in the 16th century in the form of the **Saxony wheel**, which made possible continuous spinning of coarse wool and cotton yarn. With this improvement in speed, three to five **spinning wheels** could supply one loom with yarn, but Kay's **flying shuttle** (described below under **Woven fabrics**) greatly increased the output of the loom and created a demand for spinning machinery. **James Hargreaves' spinning jenny** (patented 1770) operated a number of spindles simultaneously, but was suitable only for making yarn used as filling. Sir **Richard Arkwright**, making use of earlier inventions, produced a better machine, capable of making stronger yarn than Hargreaves' jenny. Still a third machine, **Samuel Crompton's** "mule" (1779), vastly increased productivity, making it possible for a single operator to work more than 1,000 spindles simultaneously; and it was capable of spinning fine as well as coarse yarn. Several further modifications were introduced in Britain and the **United States**, but the Crompton mule effectively put yarn spinning on a **mass production** basis.

Production of yarn » Conversion to yarn » Spinning » Modern spinning

In modern spinning, slivers or rovings are fed into machines with rollers that draw out the strands, making them longer and thinner, and spindles that insert the amount of twist necessary to hold the fibres together. Tightness of the twist determines the strength of the yarn, although too much twist may eventually cause weakening and breakage. When the spirals formed by twisted yarns are similar in slope to the central portion of the letter Z, the yarns are described as **Z-twist**; when the spirals conform in direction to the central portion of the letter S, the yarns are described as **S-twist**. Crepe yarns, producing a crinkled effect in fabrics, are made with a very high degree of twist, producing a kink. Shadow effects can be produced in finished fabrics by the use of yarns combining opposing twists, producing differing light reflections. The spinning process is completed by winding the yarn on spools or bobbins.

Production of yarn » Conversion to yarn » Spinning » Reeling and throwing

Reeling is the process of unwinding **raw silk** filament from the cocoon directly onto a holder. When several filament strands, either raw silk or man-made, are combined and twisted together, producing yarn of a specified thickness, the process is called throwing.

Production of yarn » Conversion to yarn » Yarn packages

The intended use of a yarn usually determines the **packaging** method employed. Bobbins are wood, cardboard, or plastic cores on which yarns are wound as they are spun, and have holes in their centres allowing them to fit on spindles or other holding devices. Spools are cylindrical, with end flanges. Cones, having a conical-shaped core, produce a package of conical shape; tubes, with cylindrical-shaped cores, produce cylindrical packages. Cheeses are cylindrical yarn packages wound on a tube, and, unlike most other packages, they have greater diameter than height. Skeins are coils of yarn wound with no supporting core.

Pirns are large barrel-shaped packages used to hold the weft, or filling, yarn supply for the shuttle in weaving; quills are small tapered tubes holding the weft yarns for weaving. Beams are wood or metal cylinders, about five feet long and up to 10 inches in diameter, on which yarns used as warp in weaving are wound.

Production of yarn » Types of yarn » Classification based on number of strands

Yarns can be described as single, or one-ply; ply, plied, or folded; or as cord, including cable and hawser types.

The frame knitting machine allowed production of a complete row of loops at one time. The modern knitting industry, with its highly sophisticated machinery, has grown from this simple device.

Knitted fabrics were formerly described in terms of the number of courses and wales per unit length and the weight of the fabric per unit area. This system is limited, however, and there is a shift to use of the dimensions and configuration of the single loop, the repeating unit determining such fabric characteristics as area, knitting quality, and weight. The length of yarn knitted into a loop or stitch is termed the stitch length, and in a plain knitted structure this is related to the courses per inch, wales per inch, and stitch density. The two basic equilibrium states for knitted fabrics are the dry-relaxed state, attained by allowing the fabric to relax freely in the air, and the wet-relaxed state, reached after static relaxation of the fabric in water followed by drying.

Production of fabric » Knitted fabrics » Knitting machines

The needle is the basic element of all knitting machines. The two main needle types are the "bearded" spring needle, invented about 1589, and the more common latch needle, invented in 1847.

The bearded needle, made from thin wire, has one end bent, forming an operating handle; the other end is drawn out and bent over, forming a long flexible tipped hook resembling a beard. A smooth groove, or eye, is cut in the stem or shank of the needle just behind the tip. In use this needle requires two other units, a sinker to form a loop and a presser to close the needle beard, allowing the loop to pass over the beard when a new stitch is formed. Bearded needles can be made from very fine wire and are used to produce fine fabrics.

The latch needle is composed of a curved hook, a latch, or tumbler, that swings on a rivet just below the hook, and the stem, or butt. It is sometimes called the self-acting needle because no presser is needed; the hook is closed by the pressure of a completed loop on the latch as it rises on the shaft. Needles differ greatly in thickness, in gauge, and in length, and appropriate types must be selected for specific purposes. A 4-gauge needle, for example, is used for heavy sweaters, but an 80-gauge needle is required for fine hosiery.

Production of fabric » Knitted fabrics » Weft knitting

The type of stitch used in weft knitting affects both the appearance and properties of the knitted fabric. The basic stitches are plain, or jersey; rib; and purl. In the **plain stitch**, each loop is drawn through others to the same side of the fabric. In the **rib stitch**, loops of the same course are drawn to both sides of the fabric. The web is formed by two sets of needles, arranged opposite to each other and fed by the same thread, with each needle in one circle taking up a position between its counterparts in the other. In a 2:2 rib, two needles on one set alternate with two of the other. The interlock structure is a variant of the rib form in which two threads are alternately knitted by the opposite needles so that interlocking occurs. In the **purl stitch**, loops are drawn to opposite sides of the fabric, which, on both sides, has the appearance of the back of a plain stitch fabric. **Jacquard mechanisms** can be attached to knitting machines, so that individual needles can be controlled for each course or for every two, and complicated patterns can be knitted. To form a tuck stitch, a completed loop is not discharged from some of the needles in each course, and loops accumulating on these needles are later discharged together. The plaited stitch is made by feeding two threads into the same hook, so that one thread shows on the one side of the fabric and the other on the opposite side. A float stitch is produced by missing interlooping over a series of needles so that the thread floats over a few loops in each course.

Knitting machines can be flat or circular. Flat machines have their needles mounted in a **flat plate** or needle bed or in two beds at right angles to each other and each at a 45° angle to the horizontal. The knitted fabric passes downward through the space between the upper edges of the plates, called the throat. In the knitting process, the needles are pushed up and down by cams attached to a carriage with a yarn guide, which moves over the length of the machine. The width of the fabric can be altered by increasing or decreasing the number of active needles, allowing production of shaped fabrics, which when sewn together make fully fashioned garments. Although flatbed machines are suited for hand operation, they are power driven in commercial use, and, by selection of colour, type of stitch, cam design, and Jacquard device, almost unlimited variety is possible. The cotton frame, designed to knit fine, fully fashioned goods, shaped for improved fit of such items as hosiery and sweaters, is fitted with automatic narrowing and widening devices.

Circular machine needles are carried in grooves cut in the wall of a cylinder, which may be as small as one centimetre (0.4 inch) in diameter and as large as 1.5 metres (five feet). Some circular machines have two sets of needles, carried in concentric cylinders, so that the needles interlock. During the knitting operation the butts of the needles move through cam tracks, the needles sliding up and down to pick up yarn, form a new loop, and cast off the previously formed loop. In the least complicated of these machines, yarn is supplied from one package, each needle picking up the yarn once per revolution of the cylinder. Modern machines may have as many as 100 feeders, allowing each needle to pick up 100 threads per revolution. Both latch and spring needles are used, with the former more common. Modern, large, circular, plain or jersey machines having 90–100 feeders are frequently used to produce medium-weight fabric. Small bladelike units, or sinkers, are inserted between every two needles to engage and hold the completed fabric, preventing it from riding up with the needles as they are lifted to form new stitches. Machines may be fitted with pattern wheels controlling needle action to produce tuck and **float stitches**, and a Jacquard mechanism may also be attached. Stop motions are

Circular rib machines consist of a vertical cylinder, with needle slots on the outside, and a horizontal bed in the form of a circular plate or dial with needle slots cut radially, so that the two sets of needles are arranged at right angles to each other.

Seamless **hosiery**, knitted in tubular form, is produced by circular knitting machines. Modern hosiery machines, such as the Komet machine employ double-hooked needles directly opposite each other in the same plane to knit the leg and foot portions, the heel and the toe. The toe is later closed in a separate operation. In the Getaz toe, the seam is placed under the toes instead of on top of them.

Underwear fabrics are usually knitted on circular machines, and—except for fully fashioned underwear, tights, and leotards, which are knitted to pattern and sewn together—underwear making is a cut, make, and trim operation. Tights or **panty hose** are a combination of hosiery and underwear and can be fully fashioned. Seamless panty hose are made on circular hose machines modified to make very long stockings with open tops, two of which are cut open at opposite sides and seamed together front and back. The wearing quality and fit of modern panty hose have been greatly improved with the development of stretch nylon and spandex, and greater variety has been introduced with the development of texturized yarn.

Much hosiery is finished by washing, drying, and a boarding process in which the hosiery is drawn over a thin metal or wooden form of appropriate shape and pressed between two heated surfaces. The introduction of nylon fibre led to the development of a preboarding process, setting the loops and the fabric in the required shape before dyeing and finishing. The article, fitted on a form of appropriate shape, is placed in an autoclave or passed through a high-temperature setting unit. Fabric treated in this way does not distort during dyeing.

Circular knitting machines can be adapted to make simulated furs. One type intermeshes plush loops with the plain-stitch base fabric then cuts the loops, producing a pile. A more common method forms the pile with a carded sliver. A plain-stitch fabric is used as the base and loose fibres from a sliver, fed from a brushing or carding device, are inserted by a V-shaped claw, forming the pile. Pile depth is determined by the length of the fibres in the sliver.

One of the most sophisticated knitting machines incorporates electronic selection of sinkers in a Jacquard circular **knitting machine.**

Production of fabric » Knitted fabrics » Warp knitting

The two types of warp knitting are raschel, made with latch needles, and tricot, using bearded needles.

Production of fabric » Knitted fabrics » Warp knitting » Raschel

Coarser yarns are generally used for raschel knitting, and there has recently been interest in knitting staple yarns on these machines. In the **Raschel machine,** the needles move in a ground steel plate, called the trick plate. The top of this plate, the verge, defines the level of the completed loops on the needle shank. The loops are prevented from moving upward when the needle rises by the downward pull of the fabric and the sinkers between the needles. Guide bars feed the yarn to the needles. In a knitting cycle, the needles start at the lowest point, when the preceding loop has just been cast off, and the new loop joins the needle hook to the fabric. The needles rise, while the new loop opens the latches and ends up on the shank below the latch. The guide bars then swing through the needles, and the front bar moves one needle space sideways. When the guide bar swings back to the front of the machine, the front bar has laid the thread on the hooks. The needles fall, the earlier loops close the latch to trap the new loops, and the old loops are cast off. Raschels, made in a variety of forms, are usually more open in construction and coarser in texture than are other **warp knits.**

Production of fabric » Knitted fabrics » Warp knitting » Tricot

Tricot, a warp knit made with two sets of threads, is characterized by fine ribs running vertically on the fabric face and horizontally on its back. The tricot knitting machine makes light fabrics, weighing less than four ounces per square yard. Its development was stimulated by the invention of the so-called FNF compound needle, a sturdy device that later fell into disuse but that made possible improved production speeds. Although approximately half of the tricot machines in current use make plain fabrics on two guide bars, there is increasing interest in pattern knitting. In this type of knitting, the warp-knitting cycle requires close control on the lateral bar motion, achieved by control chains made of chunky metal links.

Production of fabric » Knitted fabrics » Warp knitting » Special effects in warp knits

The scope of warp knitting has been extended by the development of procedures for laying in nonknitted threads for colour, density, and texture effects (or inlaying), although such threads may also be an essential part of the structure. For example, in the form called "zigzagging across several pillars," the ground of most raschel fabrics, the front bar makes crochet chains, or "pillars," which are connected by zigzag inlays.

An extension of conventional warp knitting is the Co-We-Nit warp-knitting machine, producing fabrics with the properties of both woven and knitted fabrics. The machines need have only two warp-forming warps and provision for up to eight interlooped warp threads between each chain of loops. These warp threads are interlaced with a quasiweft, forming a fabric resembling woven cloth on one side.

frames' and quite often there are three sets in series.
The output from the first is called 'slubbing' The output from the second is called 'inter'(mediate)
The output from the third is 'roving'
'Slubber' and 'rover' are often given as census occupations.

ROVING TO YARN (SPINNING)

The term *"spinning"* is sometimes used to denote this final process in the production of the yarn. This involves attenuating (stretching) the yarn to the required tex. Giving the thread strength by adding twist. And winding it on to a bobbin. There are two main methods:

- MULE SPINNING
- RING SPINNING

The MULE was originally developed by Samuel Crompton from the "jenny". He never patented his invention and this must have helped its wide introduction. The mule operated in two stages. In one stage the whole 'front' of the machine (perhaps 100 feet long) moved away from the back part stretching and twisting the thread as it did so. It would move several feet (say 5 feet). In stage two the front carriage moved back and at the same time wound the stretched yarn on to a bobbin (or *cop*). With the early mules the carriage was moved forward by the operators turning a wheel but the invention of the self-acting mule meant that the carriage moved forward itself. Mules would be placed in lines so that the front of one faced the front of the next. As the carriages moved forward, towards each other, only a narrow gap would be left between them for the spinner to walk between. The mules were tended by spinners, piecers, doffers. Piecers would mend broken threads and doffers would remove the full cops. Often they would be men. Mules could at one time produce much finer yarns than ring frames but as the latter have become more capable the mule has become less used.

RING-SPINNING was a development from Richard Arkwright's "water frame". Many Lancashire manufacturer's found that Arkwright's patents were too restrictive so the early water frames lost out to the mule. Ring spinning was not used much in Lancashire until the later years of the 19th century (though invented in USA in 1829) and is carried out on a machine called a ring frame. The process is continuous rather than intermittent, and higher speeds can be achieved. This became the dominant method by mid-1900s. Ring frame tenters were often women and again the full bobbins are removed by doffers. THROSTLE spinning was also developed from the water frame.

TENTER

This is as good a point as any to say something about this occupation which can have a number of meanings. The most usual meaning in Lancashire census records is someone who looks after something, cares for something, tends it. So an "engine tenter" is someone who looks after an engine. Another usage which goes back to the early days refers to the days when bleaching was carried out by putting the cloth in the sun. In small quantities the

	cloth could simply be laid on the grass but later long lines were set up in bleaching crofts and the cloth was hung from these lines on "tenterhooks". The workers who did this could be "crofters" or "tenters" or "tenterers". Looking again at the Tippett book I see he has a picture of cloth going through a bleaching machine which he calls a bleach croft. So prehaps when modern chemistry enabled bleaching to be done inside the factory the word "croft" stuck. Perhaps the term "crofters" was also applied to these inside workers.
WINDING	The yarn which emerges from the spinning process cannot usually be woven directly and needs some preparation. Winding is the process of transferring the yarn to larger bobbins or cones. The idea is to get a long continuous length. Weft-winding inolves winding on to smaller bobbins that will go into a shuttle. "Winder" is a common occupation in the census records.
BEAMING	The beam is a long cylinder with flanges and perhaps 600 threads are wound on to it side-by-side. The machine is watched over by a "beamer". The full beam is very heavy. In early days beaming was often done in the weaving mill but then tended to be transferred to the spinning mill which would send the full beams to the weavers. Note that this is more specifically called a "warper's beam"
SIZING	The yarn is a little fragile for the rough treatment imposed by the weaving process and a "size" is applied to make it more robust. A number of warper's beams (as above) are placed at the back of the sizing machine and the yarn is drawn through and wound on to a "weaver's beam". If the machine is fed by 8 warper's beams of 500 threads each then the weaver's beam will have 4000 parallel threads. Generally the set of warper's beams will produce up to 20 weaver's beams each of 1000 yards or more. The operative is called a "tape sizer" or a "taper". This was a skilled job to get the right degree of dryness.

- INTRODUCTION TO LANCASHIRE COTTON INDUSTRY
- WEAVING
- FINISHING

Last update 25/05/2005

Enclosure No. 2

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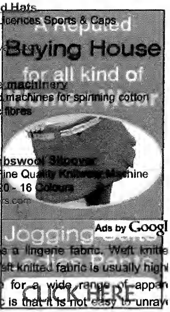
Types of Knitting

The method of converting yarn into fabric by intermeshing loops, which are formed with the help of needles is known as knitting. There are two basic forms of knitting technology: Weft Knitting and Warp Knitting. Weft knitting is done with hands, and with machines. Warp knitting is done by machines only. In weft knitting, only a single yarn is required and the fabric consists of horizontal parallel courses of yarn. On the other hand, warp knitting requires one yarn for every stitch in the row, that is the course, and these yarns make vertical parallel wales. Warp knitting is resistant to runs, and is commonly used as a lingerie fabric. Weft knitted fabrics can be produced in either tubular or flat form. Weft knitted fabric is usually highly elastic and highly drapable, which makes it suitable for a wide range of apparel applications. The main advantage of warp knitted fabric is that it is not easy to unravel like weft knitted fabric. However, this fabric is not as elastic as weft knitted fabric. Let us now study in detail the two basic types of knitting:

- Weft Knitting
- Warp Knitting



Weft Knitting

The process of hand knitting is known as weft knitting and it can also be done by machines. In weft knitting, the work progresses back and forth, that is width-wise. In each cycle which is known as course, a new row of stitches is formed. In each row there may be a number of stitches depending upon the width of the fabric to be knitted. Each stitch of the row is built-up intermeshing with the previously held stitches of the previous row. The vertical row of stitches or loops hanging vertically from the needles is known as wale. Weft knitted fabric is produced in either flat or tubular form.

Warp knitting

From Wikipedia, the free encyclopedia

Warp knitting is a family of knitting methods in which the yarn zigzags along the length of the fabric, i.e., following adjacent columns ("wales") of knitting, rather than a single row ("course"). For comparison, knitting across the width of the fabric is called weft knitting.

Since warp knitting requires that the number of separate strands of yarn ("ends") equals the number of stitches in a row, warp knitting is almost always done by machine, not by hand.

Basic pattern of warp knitting. Parallel white, red and green yarns zigzag *lengthwise* along the fabric, each loop securing a loop of an adjacent strand from the previous row. Thus, the two central wales in this picture are alternating *white-red-white* and *red-green-red* stitches.

Types

Warp knitting comprises several types of knitted fabrics, including tricot, raschel knits, and milanese knits. All warp-knit fabrics are resistant to runs and relatively easy to sew.

- Tricot is very common in lingerie.
- Milanese is stronger, more stable, smoother and more expensive than tricot and, hence, is used in better lingerie. Milanese is now virtually obsolete.
- Raschel knits do not stretch significantly and are often bulky; consequently, they are often used as an unlined material for coats, jackets, straight skirts and dresses.

The largest outlet for the Raschel Warp Knitting Machine is for Lace fabric and trimmings.

References

Shaeffer, C. (1994) *Claire Shaeffer's Fabric Sewing Guide*, updated ed., Chilton Book Co. ISBN 0-8019-7802-5

External links

- Warp knit fabrics in Italy (http://www.webplace.it/directory-english.htm)

Warp-Knitting

When producing warp-knits, a yarn sheet is linked by stitches in longitudinal direction. Thus, each individual thread in the sheet (warp) forms a wale. These Dorlastan loops give the warp-knit fabric the desired elasticity. It is this way that fabrics for corsetry, underwear, sports- and swimwear are produced.

For many fabrics, the most important requirements are elasticity and good recovery properties.

This applies, for example, to corsetry and sheer lingerie articles. The use of Dorlastan is highly recommendable in these fields, since in addition to the recovery properties it guarantees a perfect fit and absolute freedom of movement.

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Product-Info
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Warp-Knitting
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